nesians; 4. Bushmen; 5. Hottentots; 6. Negros of Soudan and Guinea; 7. Akkas; 8. Kafirs; 9. Nubas; 10. Pouls (Foulas or Fellatas); 11. Negritos; 12. Veddahs; 13. Dravidians; 14. Mundas (Kohls and Kolarians); 15. Indo-Chinese; 16. Siamese; 17. Birmese; 18. Himalayans, including Thibetans; 19. Annamites; 20. Cambodgans; 21. Chinese; 22. Japanese; 23. Ainos; 24. Hyperboreans; 25. Mongols; 26. Malays; 27. Polynesians; 28. Americans; 29. Caucasians, including Circassians, Georgians, etc.; 30. Berbers; 31. Semites; 32. Asiatic Aryans; 33. Occidentals or Indo-Europeans.

The author expressly states that his intention has been to devote much more space to the inferior than to the superior divisions of men, and to treat with detail only of those less known. As he allots only five pages out of the one hundred and fifty-six of the volume to the North-American Indians, he must consider them to be 'superior,' and well understood. But they are not apparently thoroughly understood by him. His enumeration, not only of tribes, but of the most important linguistic stocks, is imperfect and inaccurate. He is wildly at fault in many of his generalizations, some of which it seems proper to correct. The Indian is said to dwell in miserable huts made of poles united in a cone and covered with skin. It is true that the conical form of temporary lodges prevailed from obvious circumstances; but the material for covering was much more frequently of bark and mats than of skins; and the more permanent dwellings were of various styles and materials, in which neither poles nor skins appeared, and were often comfortable. The statement is distinctly made, that each family lived in its own particular hut or cabin. The rule is almost without exception, that, apart from the temporary lodges, all dwellings were adapted to the living-together of several families: in other words, they were communal. Furthermore, the error is repeated, that the Indians subsisted almost entirely on the products of the chase, supplemented only by such vegetables as were the spontaneous productions of nature, all cultivation of the earth being despised. The fact is, that every tribe east of the Mississippi and between the St. Lawrence and the Gulf of Mexico cultivated the soil sufficiently to derive an important part of its subsistence therefrom. In general it may be remarked of the author's statements regarding the North-American Indians, that, when true at all, they are true only of particular tribes, and are not of wide application. In this he has merely travelled in the path of other European writers who have regarded these people as of a single homogeneous race; whereas by the criteria of language, physical characteristics, environment, etc., used for other parts of the world, there would be as much propriety in his dividing the North-American stocks as in several of the other divisions above quoted. When, moreover, he lumps the Indians of North and South America together, he does little better and is less candid than the old geographers, who labelled a fancied line 'terra incognita.'

GAGE'S ELEMENTS OF PHYSICS.

A text-book of the elements of physics, for high schools and academies. By ALFRED P. GAGE, A.M. Boston, *Ginn, Heath, & Co.*, 1883. 10+414 p. 12°.

BECAUSE we find lightning explained as the thunder-bolts of Jove, forged by Vulcan, remembering that this was no poetical idea, but the actual belief of a simple folk; because the Indians explain the setting of the sun by saying that it has burrowed into the earth; because such gross explanations satisfy the mind not yet developed, — should we in our teaching, that our knowledge may appear the more complete, make use of such false fancies?

Many teachers find it of supposed advantage to make use of the atomic theory in explaining solution, expansion, or the fact of smell. This gives, it is true, a clear picture of a possible mechanism. But is there not a danger, when the slender grounds there are for proof of such suppositions are found out, that the student may turn away, feeling that the whole structure of physics is built upon such conceits?

There is the satisfaction of a clear picture, which can be understood and compared with more tangible phenomena. But is not this a loss, when obtained at the expense of bringing in a conception of matter for which there are reasons, but reasons of a nature which cannot be appreciated by the beginner?

This prominence of atoms is an old bugbear of elementary text-books. Yet our knowledge in regard to them only dates from ten or twenty years ago, or, as Thomson would have it, from the work of Caudey on the dispersion of light. To be sure, the word 'atom' may be found in many a metaphysical discussion; but how could such wranglers, switching at phantoms, be expected to hit so small a thing?

It would seem safer to leave the causes of the general properties of matter as entirely unknown. When the child asks what becomes

of the sugar when dissolved, say we do not know.

Beyond this fault, which is common, the book is of merit as giving many experiments with apparatus of easy make. There is at times a lack of exact knowledge displayed, as from one who has studied in the schoolroom and not in the physical laboratory. But with the young learner the work will, without doubt, prove fresh and instructive.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Virtual change of the astronomical unit of time. — Mr. E. J. Stone has recently communicated to the Royal society an important paper on a virtual change of the astronomical unit of time, which has taken place in consequence of the difference between Bessel's expression for the sun's mean longitude and the corresponding formulae of Hansen and Leverrier. The investigation was primarily undertaken for the purpose of finding an explanation of the rapidly increasing discordance between the moon's place and that indicated by Hansen's lunar-tables; and, after a careful examination of a number of other hypotheses, Mr. Stone thinks he has found the cause as indicated above.

For the sun's mean longitude, —

Bessel gives $\odot = 280°46'36''.12 + 1{,}296{,}027''.6182\,t + 0''.00012218\,t^2$,
Hansen " $\odot = 280°46'43''.20 + 1{,}296{,}027''.6741\,t + 0''.00011069\,t^2$,
Leverrier " $\odot = 280°46'43''.51 + 1{,}296{,}027''.6784\,t + 0''.00011073\,t^2$,

in which t is reckoned, *as supposed*, in Julian years from Jan. 1, 1850, Paris mean noon. Now, the old observations which Hansen used in forming his lunar-tables, and in determining its constants, were reduced according to Bessel's formula. When we compare tables, thus formed, with observations in which the date of observation is referred to the sun's place by means of Leverrier's or Hansen's tables of the sun, just such a discordance must arise as if the length of the unit of time had altered; i.e , as if Bessel's Julian year were different from Leverrier's, which is now used in our ephemerides, having been adopted about 1864. Up to 1863, Hansen's lunar-tables were satisfactory: since then, the error of the moon's longitude has increased from $+0''.121$ to $+10''.265$.

Mr. Stone thinks this will also clear up some perplexing discrepancies in results as to the moon's secular acceleration. He points out that Hansen's tables "cannot safely be used in the discussion of ancient eclipses until the effects of this confusion of units of time have been cleared." [This abstract is made, not from the paper itself, which is not yet printed, but from an account given of it by Mr. Stone to the Royal astronomical society.] — (*The observ.*, May.) C. A. Y. [1014

MATHEMATICS.

Sub-invariants. — In the two instalments of his memoir which have thus far appeared, Prof. Sylvester enters upon a new development in the modern algebra; namely, the theory of semi-invariants regarded as belonging to a quantic of unlimited order, in which aspect he designates them as sub-invariants. An important distinction between regarding a semi-invariant as appertaining to a particular limited quantic and regarding it as a sub-invariant, is, that it may, while irreducible in the former character, be reducible in the latter. The new problem thus arises of determining the absolutely irreducible sub-invariants of any given degree and weight. In section I. a number of general theorems are established concerning sub-invariants appertaining to a single quantic, and to systems of quantics, all of unlimited order; and a method is indicated by which the author has succeeded in disproving the proposition that ground-forms and syzygants cannot coexist. Section II. contains tables of 'germs' for the quintic and sextic, the germ of a sub-invariant being the multiplier of the highest power of its last letter. Section III. is devoted to a systematization of the method of deducing the complete system of ground-forms of a quantic by direct algebraical operation from the simplest system of forms in terms of which any other form, multiplied by a power of the quantic, can be rationally and integrally expressed. The method is due to Prof. Cayley, and is easily applied to the cubic and the quartic; but, beyond these very simple cases, its application would be practically impossible without the aid of the methods now introduced by Prof. Sylvester. The application to the quintic is given *in extenso*. Section IV. treats of absolutely irreducible sub-invariants; the generating functions are obtained for absolutely irreducible sub-invariants of the first seven degrees; from the generating function for the seventh degree it is inferred that ground-forms and syzygants must necessarily coexist in the case of quantics of a sufficiently high order, which constitutes the disproof above referred to. This section is followed by an excursus on rational fractions and partitions. (See **1016**.) — (*Amer. journ. math.*, v. 1, 2.) F. F. [1015

Rational fractions and partitions. — In an excursus on this subject, Prof. Sylvester gives, in an improved and more complete form, the theory of simple denumeration first published by him in 1855. The object of the theory is to find an analytical expression for the general coefficient in the expansion of the generating function; but its cardinal theorem applies to the expansion of any rational fraction, and not only of such as arise in the theory of partitions or denumeration. — (*Amer. journ. math.*, v. 2.) F. F. [1016

PHYSICS.

Heat.

Radiation and absorption of rock-salt. — Herr C. Baur has made some observations on this subject. His results do not agree with those of Melloni and Magnus. Melloni considered that heat, radiated from rock-salt, was not absorbed by plates of rock-salt, any more than heat radiated from other substances. Magnus found that rock-salt plates absorbed heat radiated from rock-salt much more than that radiated from other substances. He believed that the radiation from perfectly pure rock-salt would be completely absorbed by a plate of the same substance, and that the apparent exceptions to this law were due to impurities in the radiating plate. Herr Baur concludes from his experiments that, 1. Rock-salt absorbs its own radiations better than those from